Structural Relation Between Mortgage and Market Interest Rates

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Abstract

This paper analyzes the dynamic relationship between primary and secondary mortgage markets and the short-term and long-term market interest rates. Using a series of monthly data on fixed rate mortgage rates and GNMA rates, we explore the dependence and speed of adjustment in these primary and secondary mortgage rates to each other as well as to the long and short-term government rates. The results indicate that residential mortgage rates in general, appear to follow the long-term rate and are not very sensitive to movements in the short-term interest rate.

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1 Introduction

The valuation of mortgage-backed securities has been extensively examined in the literature. Beginning with the seminal work of Brennan and Schwartz (1979, 1982) on the pricing of bonds, Dunn and McConnell (1981a,b), Brennan and Schwartz (1985), Green and Shoven (1986), Ramaswamy and Sundaresan (1986) and Schwartz and Torous (1989, 1992) have all advanced models for the pricing of interest-rate sensitive mortgage-backed securities.

There is a distinctly different but parallel body of literature which examines the behavior and characteristics of the underlying residential and commercial mortgages. However, unlike commercial mortgages, which have been studied by Kau (1987), Titman and Torous (1989) , Hannan and Liang (1995) and Benjamin, Heuson and Sirmans (1995) among others, the behavior and pricing of residential mortgages has received far less attention in the academic literature. This may be due in part to the fragmented nature of the residential mortgage market, as well as the recent increase in both mortgage securitization and refinancing of residential mortgages. In addition, the recent period of low and stable interest rates may have also contributed to relatively less attention this topic may have otherwise received.

In an attempt to fill this void, this paper provides an analysis of the dynamic relationship between the primary and secondary residential mortgage rates and their relationship to the short-term and long-term interest rates. We focus our attention on the inter-relationships among the various mortgage rates and market interest rates as well as the direction of causality between them. Specifically, using a series of monthly data on fixed rate conventional mortgages and another on GNMA mortgage rates, we explore the dependence and the speed of adjustment in these mortgage rates relative to short and long term interest rates.

The conventional mortgage market continues to offer both fixed and adjustable rate mortgages. The adjustable rate mortgage is reset periodically to reflect changes in the general interest rates. The barometer for interest rate changes is usually some index, either the one-year constant-maturity treasury rate, a federal home bank board district cost of funds rate, or the London inter-bank offer rate (LIBOR). It is important to note that while these indices are the ones cited by most banks as the ones they use in adjusting their mortgage rates, there is no unanimity among banks regarding this adjustment procedure. This observation suggests that it is perhaps supply and demand conditions in the given market that often determine conventional mortgage rates.

In recent years, approximately 50 percent of the residential mortgages originated in the United States have been securitized. Most of these are pass-through securities that are guaranteed, for a fee, by the Government National Mortgage Association (GNMA), or by one of the two government-sponsored enterprises; the Federal National Mortgage Association (FNMA) and the Federal Home Loan Mortgage Corporation (FHLMC). To qualify for an agency guarantee, the loan must be conforming to certain size and quality standards.

The Federal Reserve's decision to change the short-term interest rates often reverberates into the longer-term markets and quickly impacts residential and commercial mortgage markets. Moreover, the home building sector, which is highly sensitive to interest rate swings, is significantly impacted as interest rate hikes are generally reflected in higher overall mortgage rates.

To address questions relating to the dynamic relation between residential mortgage rates and market interest rates, we posit the following questions; How are changes in mortgage rates impacted by changes in the short-term and long-term market rates? How long does it take for mortgage rates to fully adjust to changes in interest rates? How large is the premium in the conventional rate mortgage over the GNMA mortgage rate? These and other related questions are examined using Granger causality, regression analysis and vector autoregression (VAR) methods.

This paper is organized in five sections. Section 2 discusses the data and presents summary statistics for all of the series examined. Correlation results and autocorrelations results among the variables are also presented. Section 3 provides Granger causality results between conventional and GNMA mortgage rates on the one hand and short-term and long-term interest rates on the other hand. Section 4 presents the VAR results along with the related impulse response functions. The final section provides a brief summary and some concluding remarks.

2 Data

The data for the analysis is obtained from the Wall Street Journal and the Federal Reserve Board of Governors homepage. We use monthly data for the period January 1989 to December 1996 on 30 year mortgage securities FNMA, GNMA, FHLMC and conventional mortgages. The proxy for the short term rate is the three month t-bill rate and for the long term, the ten year government bond rate. Table 1 gives some descriptive statistics on all the variables used in this study. Table 2 shows the correlation between these variables. The nearly perfect correlation between the FNMA, GNMA and FHLMC rates suggest that using all of the three variables might prove redundant. Hence we focus only on GNMA data. Conventional mortgages however, have somewhat different characteristics. For example, its mean and standard deviation are higher than the GNMA rates. We analyze both GNMA and conventional mortgage rates to draw conclusions about relationships between mortgage rates and the interest rates. Liquidity premium is calculated by taking the difference between conventional rate and the GNMA rate. Term premium refers to the difference between the long term rate and the short term rate on government securities. Term premium is essentially the slope of the yield curve.

The liquidity premium variable is incorporated to examine whether there is a systematic difference between the behavior of the rates on conventional mortgages and those of the more liquid GNMA rates. Furthermore, it is important to understand how this liquidity premium might change over the business cycle. In addition, the term premium variable is incorporated to study the reaction of the mortgage rates to the short and long term interest rates during recessionary time periods as well as during times of economic expansions. It has been suggested that mortgage rates respond faster to rising than declining interest rates.[1]

[1]The term premium has been shown to predict business cycles. Stock and Watson (1989, 1990a,b, 1993) have found that the slope of the yield curve is one of the two most potent leading variables for predicting business cycles. Chen (1989) and Harvey (1989) have shown that the slope of the yield curve contains additional and independent information that enhances the predictability of the future levels of real economic activity. More recently, Lahiri and Wang (1996) find that the slope of the yield curve outperformed all other variables in predicting turning points in business cycles.

Table 1

Summary Statistics of All Rates

This table shows summary statistics for FNMA, GNMA, FHLMC and conventional mortgage rates, the long-term 10 year bond rate and the 3 month t-bill rate. Liquidity premium is the difference between conventional rate and the GNMA rate. Term premium is the difference between the 10 year bond rate and the 3 month t-bill rate.

Variable	Mean	Std. Dev.	Max	Min
T-bills	5.32	1.85	8.83	2.85
Bonds	7.33	1.04	9.30	5.33
Conventional	8.82	1.13	11.05	6.83
GNMA	8.32	0.98	10.29	6.25
FHLMC	8.27	1.20	10.42	5.39
FNMA	8.26	1.23	10.45	5.27
Liquidity	0.45	0.29	1.11	-0.30
Term Premium	2.07	1.02	3.74	-0.12

Table 2

Correlation Among Different Rates

This table shows the correlations between FNMA, GNMA, FHLMC and conventional mortgage rates, the long-term 10 year bond rate and the 3 month t-bill rate.

Variable	T-bills	Bonds	Conventional	GNMA	FHLMC	FNMA
T-bills	1	.82	.87	.87	.86	.86
Bonds	.82	1	.97	.97	.96	.96
Conventional	.87	.97	1	.97	.96	.96
GNMA	.87	.97	.97	1	.99	.99
FHLMC	.86	.96	.96	.99	1	.99
FNMA	.86	.96	.96	.99	.99	1

2.1 Unit Root Test

To check for stationarity in the variables, we performed the following Augmented Dickey-Fuller unit root test.

$$\Delta x_t = \alpha + \beta x_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta x_{t-j} + u_t$$

where Δ is the difference operator, u_t is white noise, p is the optimal lag in the autoregressive representation of x_t. If the autoregressive representation of x_t contains a unit root, the t-ratio for the parameter β should be consistent with the hypothesis $\beta = 0$. Since the conventional t tables are inappropriate for this hypothesis test, Dickey and Fuller (1979) and Fuller (1976) results have been used to interpret the t-ratio.[2]

According to the above unit root test, the rates on GNMA, conventional mortgage, t-bills and bonds are all non-stationary in levels but are first difference stationary. Liquidity and term premium are stationary in levels.

Table 3

Autocorrelations of Variables

This table shows twelve month lag autocorrelations of GNMA, conventional mortgage, t-bills, bonds, liquidity premium and term premium.

Variable	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_7	ρ_8	ρ_9	ρ_{10}	ρ_{11}	ρ_{12}
GNMA	.94	.86	.78	.72	.68	.63	.59	.53	.48	.44	.41	.37
Convent	.96	.89	.83	.77	.72	.68	.64	.60	.55	.51	.46	.42
T-bills	.99	.96	.94	.91	.89	.85	.82	.78	.75	.71	.67	.63
Bonds	.93	.85	.79	.75	.69	.64	.59	.54	.49	.45	.43	.41
Liquidity	.62	.53	.52	.49	.44	.47	.48	.41	.40	.36	.34	.29
Term	.95	.89	.84	.79	.74	.67	.60	.53	.45	.37	.30	.23

[2] The Augmented Dickey Fuller test results are available from the authors.

Table 3 shows the 12 lag autocorrelations of GNMA rates, conventional mortgage rates, t-bills, bonds, liquidity premium and the term premium. The gradual decay in autocorrelations of GNMA, conventional rate, t-bills and bonds confirms the potential presence of an integrated component. Table 4 explores the contemporaneous relation between changes in long term and short term interest rates versus changes in the mortgage rates. The first difference of mortgage rates is regressed on the first difference of the t-bill rate and the bond rate. Changes in GNMA mortgage rate are significantly positively correlated with the changes in the ten year long term bond rate but has no significant relation with the changes in the short term t-bill rate. On the other hand, changes in the conventional mortgage rates has significant relation with both changes in the short term and long term rates. The conventional mortgage rate is a composite average of many mortgage lenders. It reflects how lenders on average adjust to changes in interest rate fluctuations.

Table 4

Relation between Changes in Mortgage Rates and Interest Rates

The first part of this table shows how changes in the three month t-bill rate and ten year bond rate affect changes in the conventional and GNMA mortgage rates. The second part shows results with two additional variables i.e. the liquidity and term premium. Δ represents the first difference. The numbers in parentheses show the t-statistic. The $(*)$ shows that the variable is significant at 95% confidence level.

$$\Delta y_t = \alpha + \beta_1 \Delta Tbills + \beta_2 \Delta Bonds + \zeta_t$$

y_t	β_1	β_2	R^2
GNMA	0.02	0.67	0.37
	(0.17)	$(5.83)^*$	
Conventional	0.25	0.61	0.69
	$(3.17)^*$	$(9.72)^*$	

$$\Delta y_t = \alpha + \beta_1 \Delta Tbills + \beta_2 \Delta Bonds + \beta_3 liquidity + \beta_4 term + \eta_t$$

y_t	β_1	β_2	β_3	β_4	R^2
GNMA	-0.11	0.57	-0.48	-0.02	0.55
	(0.89)	$(5.62)^*$	$(5.55)^*$	(1.11)	
Conventional	0.26	0.61	0.03	0.01	0.69
	$(3.17)^*$	$(9.38)^*$	(0.53)	(0.64)	

Another important result emerges from the regressions in Table 4. When the variables liquidity and term premium are incorporated into the regressions, the R^2 increases from 37 percent to 55 percent for the GNMA regression. There is clearly no such effect on the conventional mortgage regression. More interestingly, the liquidity premium coefficient of 0.48 confirms the common belief that the increased liquidity of the GNMA securities often allows these rates to be 50 basis points below other mortgage rates.[3] This result is consistent with Schwartz and Van Order (1988).

3 Granger Causality Tests

To explore whether the mortgage rates are Granger caused by short term rates and/or long term rates, we first do a Granger causality test. Granger states that a variable x is said to cause another variable y if current values of y can be predicted better by using past values of x than by not using them.

$$y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \cdots + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \cdots + u_t$$

[3]The 5 basis point premium mentioned in the introduction applies to government backed securities.

x Granger causes y or x helps predict y if $\beta_i \neq 0$ for some i. Table 5 shows the regression of mortgage rates on t-bill rates. The numbers in parentheses show the t-statistic. The lagged coefficients of t-bill rates cause GNMA rates but are shown not to Granger cause conventional mortgage rates. By examining Tables 4 and 5 we can see that although there is no contemporaneous relationship between GNMA and t-bill rates, the lagged values of t-bills do Granger cause GNMA rates. On the other hand, the conventional rates have significant relation with contemporaneous t-bill rates but have no causality effect from t-bill rates.

Table 5

Causality Tests between Mortgage Rates and T-bills

This table shows the Granger causality tests between two different kinds of mortgage rates i.e. GNMA, conventional mortgage and the three month treasury bill rates. Δ is the difference operator. The numbers in parentheses show the t-statistic. The ($*$) shows that the variable is significant at 95$\%$ confidence level.

$$\Delta y_t = \alpha + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \beta_3 \Delta Tbills_{t-1} + \beta_4 \Delta Tbills_{t-2} + \eta_t$$

y_t	β_1	β_2	β_3	β_4
GNMA	0.06	-0.05	0.40	-0.43
	(0.56)	(0.43)	(1.99)*	(2.36)*
Conventional	.54	-0.25	0.06	-0.04
	(4.34)*	(2.03)*	(0.43)	(0.30)

Table 6 shows the regression of mortgage rates on long term bond rates. The one month lagged coefficients of bond rates show significant causality relation with the mortgage rates. In case of both GNMA and conventional mortgage, one month lagged bond rates positively impact the mortgage rates. The two month lagged bond rate coefficient has no impact on the GNMA and conventional mortgage rates. This implies that the mortgage rates adjust to changes in bond rates within one month period.

Table 6

Causality Tests between Mortgage Rates and Bonds

This table shows the Granger causality tests between different kinds of mortgage rates i.e. GNMA, conventional mortgage and the ten year bond rates. Δ is the difference operator. The numbers in parentheses show the t-statistic. The $(*)$ shows that the variable is significant at 95% confidence level.

$$\Delta y_t = \alpha + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \beta_3 \Delta Bonds_{t-1} + \beta_4 \Delta Bonds_{t-2} + \epsilon_t$$

y_t	β_1	β_2	β_3	β_4
GNMA	-0.14	-0.26	0.51	-0.01
	(0.92)	(1.50)	$(2.59)^*$	(0.05)
Conventional	0.09	-0.26	0.45	0.08
	(0.53)	(1.72)	$(3.18)^*$	(0.57)

The results in Table 5 and 6 are consistent with the initial regression results presented in Table 4. GNMA rates are influenced by lagged rather than contemporaneous t-bill rates. The contemporaneous bond rate and the one month lagged bond rate are both positively related to the GNMA rate. Conventional rates are also affected by bond rates in the same manner. The t-bills on the other hand, do not Granger cause conventional rates like GNMA rates. Specifically the long term rate appears to be far more influential in determining the rates on conventional mortgages.

4 Vector Autoregression

Vector autoregression determines patterns in variables by estimating a system of equations in which each variable is related to the past values of itself and all the other variables in the system. In the general case,

$$\mathbf{y_t} = \mu + \rho_\mathbf{1}\mathbf{y_{t-1}} + \cdots + \rho_\mathbf{p}\mathbf{y_{t-p}} + \mathbf{v_t} + \theta_\mathbf{1}\mathbf{v_{t-1}} + \cdots + \theta_\mathbf{q}\mathbf{v_{t-q}}$$

where $\mathbf{y_t}$ and $\mathbf{v_t}$ are vectors of random variables, μ is the mean vector, ρ_1**, ...,** ρ_p**,** θ_1 **, ...,** θ_p are the parameter matrices. This produces a vector ARMA model. Most of the applications, including this study, are based on simpler models without moving average terms. The resulting model,

$$\mathbf{y_t} = \mu + \rho_\mathbf{1}\mathbf{y_{t-1}} + \cdots + \rho_\mathbf{p}\mathbf{y_{t-p}} + \mathbf{v_t}$$

is a vector autoregression or VAR model.

The quality of forecast depends on the choice of the variables. The number of variables and the number of lags cannot be arbitrarily increased to improve the accuracy of the forecasts. Estimating too many coefficients with limited amount of data can cause occasional past deviations from the fundamental pattern to be incorporated into the estimates of the coefficients. In order to avoid past one time deviations and capture the true fundamental pattern, the number of variables and number of lags should be carefully modeled. All the variables used here are estimated in first differences since the levels are non stationary. Table 7 shows that the VAR(1) estimation results of the conventional and GNMA rates. In the presence of both short term and long term rates, the effect of short term rates in causing the mortgage rates is minimal. This is consistent given that the long term and mortgage rates have similar characteristics.

Table 7

VAR(1) Estimation of GNMA and Conventional Mortgage, Short Term and Long Term Rates

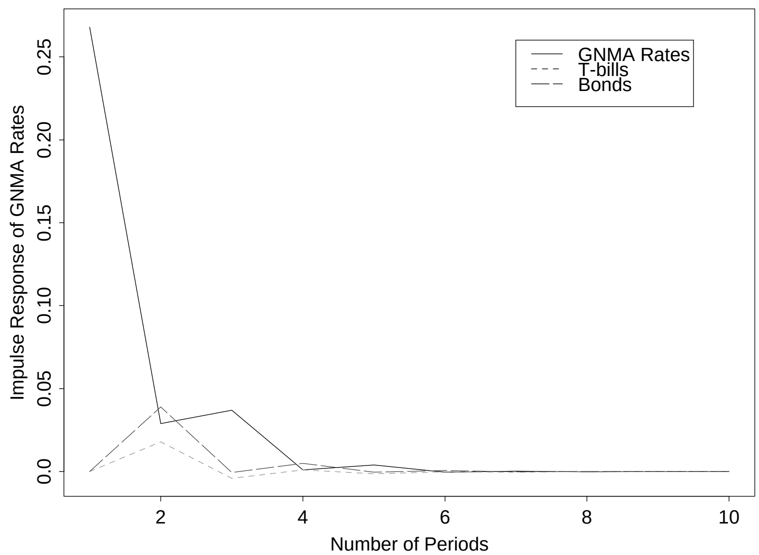
This table shows the VAR(1) estimation of GNMA mortgage, Conventional mortgage, three month t-bill rates and ten year bond rates. The numbers in parentheses show the t-statistic. The $(*)$ shows that the variable is significant at 95% confidence level. The values of R^2, Adj R^2 and Akaike information criterion (AIC) is given in the last three columns respectively.

$$\Delta y_t = \alpha + \beta_1 \Delta y_{t-1} + \beta_2 \Delta Tbills_{t-1} + \beta_3 \Delta Bonds_{t-1} + \eta_t$$

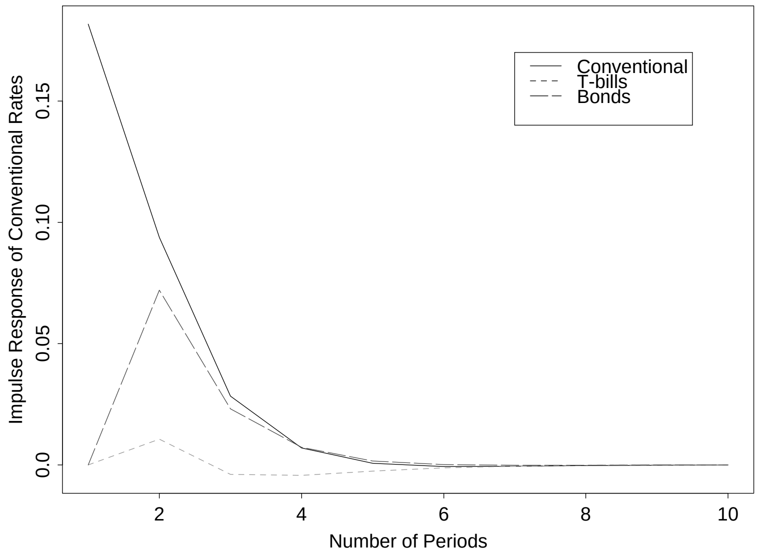
y_t	α	β_1	β_2	β_3	R^2	Adj R^2	AIC
GNMA	-0.03	-0.04	0.01	0.28	0.05	0.02	6.68
	(1.00)	(0.29)	(0.06)	(1.65)			
Convent	-0.02	-0.03	-0.02	0.52	0.32	0.29	3.05
	(1.15)	(0.16)	(0.14)	$(3.74)^*$			

Figure 1 shows the impulse response function of GNMA rates to innovations in GNMA rates, long term bond rates and t-bill rates. The impulse response function traces the dynamic effects of shocks in the short and long term interest rates on future GNMA rates. Figure 1 shows that the innovations in bonds have more influence in affecting GNMA rates than the innovations in t-bill rates. The gradual decay of the response function shows that GNMA rates take 4 to 6 months to completely adjust to the changes in short term and long term interest rates.

Figure 2 shows the impulse response function of the conventional mortgage rates to innovations in conventional rates, long term bond rates and three months t-bill rates. The innovations in bond rates have much more significant effect on future conventional rates than on future GNMA rates. The innovations in t-bills



GNMA Rates
T-bills
Bonds
Impulse Response of GNMA Rates
0.0
0.05
0.10
0.15
0.20
0.25
2
4
6
8
10
Number of Periods



Period	Δ GNMA	Δ T-bills	Δ Bonds
1	100.00	0.00	0.00
2	97.51	0.45	2.03
3	97.53	0.46	2.00
4	97.49	0.46	2.03
5	97.49	0.46	2.04

Table 9

Variance Decomposition of Conventional Mortgage Rates

This table shows the variance explained in the conventional mortgage rates. The variables explaining the variance are innovations in conventional mortgage rates, t-bill rates and long term bond rates.

Period	Δ Conventional	Δ T-bills	Δ Bonds
1	100.00	0.00	0.00
2	88.72	0.23	11.04
3	87.89	0.26	11.83
4	87.78	0.29	11.91
5	87.76	0.31	11.92

As is widely accepted, the variance decompositions are sensitive to the ordering of the VAR variables (Bomfim (1997)). In our analysis, we have placed bonds the last, an assumption that potentially works against the hypothesis that it is important in explaining the variance in the endogenous variable. The results show that the mortgage rate shocks explain most of the variation in the mortgage rates at all forecasting horizons. However, the bonds even though placed last in the VAR ordering, contribute more in explaining the fluctuations in the mortgage rates than the short term rates. The innovations in the short term rates hardly affect the mortgage rates. Note that conventional mortgages are driven more by the innovations in the bond rates than the GNMA mortgage. The VAR results provide support to the Granger causality results that the long term rates have more significant relation with the mortgage rates than the short term rates.

5 Summary and Conclusions

This paper examined the structural relationships among the various mortgage rates and the long and short term interest rates. In addition to regression analysis, this paper utilized unit root tests, Granger causality tests and vector autoregression techniques to study the inter-relationships among the variables.

Several important conclusions emerge. Perhaps the most important finding of this paper is that the mortgage rates as measured by the GNMA rates and the conventional mortgage rates are shown to closely follow the long term interest rates as represented by the 10 year Government bond rate. More importantly, changes in the short-term rates had little or no direct effect on mortgage rates. Further analysis using impulse response functions showed that any changes in the long-term interest rate is completely reflected on both the conventional and the GNMA rates within a period of one month. The dependence of the mortgage rates on changes in the long-term rates alone may have important implications regarding the stability of rates in the mortgage market since it represents a unique investment vehicle for institutional investors.

Another interesting finding relates to the expected higher liquidity premium afforded to the GNMA relative to the conventional mortgage rates. It was shown that GNMA mortgages commanded a liquidity premium estimated in our regressions to be 0.48. This estimated premium could be interpreted to reflect approximately a 50 basis point premium over conventional mortgage rates. The added marketability, standardization and perhaps even the guarantees that are enjoyed by GNMA over conventional mortgage rates, give rise to this liquidity premium.

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